

# The Biology of the North American Crane Flies (*Tipulidæ* *Diptera*)

CHARLES PAUL ALEXANDER,  
ITHACA, N. Y.\*

## IV. *The Tribe Hexatomini.*

The tribe Hexatomini includes the four genera, *Hexatoma*, *Cladolipes*, *Eriocera* and *Penthoptera*, representatives being found in all portions of the temperate and torrid zones with the exception of the Australasian region. The Nearctic genera will be considered in the order given above.

### HEXATOMA Latreille.

This genus includes a small number of forms with a Holarctic distribution, there being thirteen European and one North American species as yet described. Our fragmentary knowledge of the life-histories of members of this genus was indicated in a paper by Mr. Lloyd and the author. (The genus *Eriocera* Macquart, 1914 *Journal of Entomology and Zoology*, vol. VI, 12.)

HEXATOMA MEGACERA Osten Sacken.

*Hexatoma megacera* Osten Sacken; *Proc. Acad. Nat. Sci. Phila.*, 242, 1859.

This is the only Nearctic species as yet discovered. It is found throughout northeastern America, the distribution of the insect so far as known being as follows:

*New York*, Fulton Co., Sacandaga River, June 6-18, 1909; Johnstown, May 24, 1909 (Alexander); Tompkins Co., Ithaca, May 3-15, 1912 (Alexander). *Connecticut*, Litchfield Co., Chapinville, May 26, 1904 (Britton). *Maryland*, Osten Sacken's type; Montgomery Co., Cabin John Bridge, April 28, 1912 (Malloch). *District of Columbia*, Washington, early spring, Osten Sacken's type. *Virginia*, Fairfax Co., Glencarlyn, May 1, 1910 (Knab).

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\*Contribution from the Linnological Laboratory of the Department of Entomology in Cornell University.

The life-history of this very interesting species is still not well known. The larva lives in gravel or sand along the banks of streams. On April 26, 1914, some gravel from the banks of Cascadilla Creek, Ithaca, N. Y., was examined near the place where the pupal skins were found in 1913 (see later). No signs of larvæ or pupæ were discovered after a close search. On May 6, the same bank was examined and some ten larvæ and seventy-five pupæ were found. They occurred in the gravel that was thickly penetrated by grass-roots and rhizomes; pure gravel was nearly destitute of these insects. Associates of these larvæ and pupæ at this time were *Paederus littorarius*, *Laccobius agilis*, many larvæ and pupæ of *Tabanidae* and a few *Eriopterine* crane-fly larvæ. Some of the larvæ pupated during the night while in water contained in a flat porcelain dish. The above data seems to indicate that the larval existence is spent in or under the water of the stream and the larva comes to live in the sand along the edge of the stream only when fully grown and ready to pupate.

The pupa occurs in the sand as described above, usually in company with the larvæ of the species and various associates. The following data is taken from my field notes, May 2, 1913: Two fully grown pupæ and several cast pupal skins were found on a pebbly beach along Cascadilla Creek. They were much rarer than the adult flies of two years ago and the number of cast skins per square foot for any place was only three or four, nothing like the numbers found in the related *Eriocera longicornis* Walker. May 3, 1913. One pupa found on a pebbly beach along the Inlet (Ithaca) by J. C. Faure. It was in the loose sand with such natural associates as the following: larvæ and pupæ of the deer-fly, *Chrysops excitans*, and many adult beetles, *Cicindela sexguttata*, and *C. vulgaris*, common; *Elaphrus ruscarius*, a few; *Tachys*, sp., several; *Omophron*, sp., *Dyschirius sphaericollis*, *Agonoderus partarius*, *Anisodactylus discoideus*, *Cryptobium bicolor*, *Paederus littorarius*, *Bledius*, sp., etc. The pupa of *Hexatoma* occurred in the same stratum as the adults of *Omophron*.

The adult insects fly during May and June and may be swept from rich vegetation near the streams from which their larvæ emerged.

The following notes on the copulation, resting positions, egg-laying in nature and captivity, and other details may be quoted from field observations.

May 14, 1911—This usually rare insect was common on a grassy plot of land along Cascadilla Creek. The flies sit on the blades of grass, the long antennæ of the male directed straight ahead. The males are very poor fliers and prefer to drop to the ground when disturbed and clumsily work their way off along the ground. When approached from the side they are much more easily alarmed and fly away. When approached from above, they do not move until the stick, finger, or whatnot, is within a couple of inches, when they remove the fore feet from the support and, on nearer approach, fall to the ground. When in copulation, the female tries to disengage by rapidly vibrating the wings in attempted flight, repeating this often, from every 1 to 5 seconds until disengaged or exhausted. The male can disconnect himself at will. In copulation the female is always uppermost unless exhausted, when both sexes lie flat on a grass-blade. The female has the head up, the male the head downward; copulation always takes place on a vertical support, usually a blade of grass, sometimes a plant stem. The sexes remain in copulation for quite a long time and are perfectly motionless. All of the legs of both sexes are on the support unless in a position where this is physically impossible, in which case as many as possible are used; the hind legs of both sexes are held at right angles to the support, the forelegs in front. After copulation the female generally drops to the ground, the male, after a few moments' rest, flies away. Specimens in copulation were found in abundance from 2 to 4:30 p.m. when no more could be discovered. From 4:30 to 7 p. m. solitary males were common, but no females could be found on the grass-blades. At 4:30 p. m., a few females were found clinging to the trunks of the willow trees about two feet from the ground. At 5:30 p. m., females were noted in small groups over the water, evidently engaged in oviposition, as they frequently dipped down to the surface. These latter were in company with a large swarm of dancing Empidid flies (*Rhamphomyia*). Of the great numbers that were picked from grasses in the afternoon a considerable proportion were fe-

males and toward 5 p. m. they commenced egg-laying on the sides of the containing vessel, large shell vials. By 7 p. m. the sides of the vials were black in places with the large, dark-colored eggs. This data would seem to place the time for oviposition at about sunset. The females are very good fliers and often travel for long distances before alighting as is shown toward sunset when they fly for long stretches up-stream. The males are rather poor fliers, due in part, possibly, to the weight of the long antennæ and, as stated before, this sex prefers to skulk rather than fly. When the males fly, they do so heavily and seize the first support that they collide with and hang on, occasionally flying on immediately to another support. When the male comes in contact with a stem, he very often ascends to the top by means of a part-flying, part-climbing motion and, on reaching the summit, flies off to another place. As a rule the flies, especially the females, alight on a single grassblade, but very often the males are observed on two blades, the legs of one side on one blade and those of the opposite side on the other; when the body thus hangs between the stalks, the tarsi diverge from one another, whereas on a single support, the legs converge.

*Hexatoma* was preyed upon by large numbers of a Scatophagid fly that occurred in great abundance in this vicinity and seemed to be subsisting almost entirely on these flies. At least twenty of these predaceous flies were noted with *Hexatomæ* and this species seemed to constitute the principle insect enemy of the crane-fly. They would lurk on the grass-blades and sally forth after their prey, carrying it back to some point to feed upon it. It is probable that the blood is taken since the body of the *Hexatoma* appeared almost uninjured when examined. On an old beam where males had a habit of walking up the vertical face, a small spider's web was found, in which 11 specimens were entangled, 2 being still alive; 8 of these were males, the remaining 3, females.

The males especially can walk up smooth surfaces, as glass, moving the legs alternately and awkwardly. The first pair taken were in copulation but in placing them in the vial they became disengaged and ran about in the container. After a short time they began to copulate in the tube.

May 15, 1911—A pair were taken in copulation at 10 a. m.; at 8 p. m. they were still in coitu, but this is exceptional as most of the pairs disengage very readily. In the morning the species is very active and although the males do not fly far, they fly readily and it is difficult to pick them up by hand. The females are excellent fliers especially in the morning.

Several pairs were taken in copulation and each pair was isolated in a separate vial in order to ascertain the number of eggs per female. The clutch was determined by dissection. When the captive insects began to oviposit, the eggs shot out from the body, at first slowly, then more rapidly, one per second, later much slower again, the eggs being extruded one at a time. The total period of oviposition required seven minutes; at the end of 60 seconds, in the space between 60 and 70 seconds, 18 eggs were laid, or 1.8 per second. Toward the end of egg-laying, the eggs appeared much more slowly, one in two seconds. The eggs are quite sticky or viscid and adhere to the glass. When the female is in danger of death, as when she falls into the water, she begins, at once, to deposit the egg-complement. In nature it seems probable that one egg is laid at each descent to the water. As soon as the female touches the water, although she has not deposited an egg all day, she immediately starts to deposit the oblong black eggs. After the last egg is expelled the muscles of the ovipositor still go through the motions of expulsion. One specimen was placed in the water and as usual began to deposit her eggs. She was decapitated, laid 11 eggs and tried to lay still more but failed. The number of eggs laid varied from 316 to 372 with an average of 347; the time required for oviposition varied from 7 minutes to 7 minutes and 40 seconds. In most cases the number of the egg-complement is probably between 300 and 400.

## DESCRIPTION OF THE IMMATURE STAGES

### LARVA

Length: Fully extended, 14-15 mm.; diameter, 1-1.3 mm.

Body of the larva with rather abundant appressed hairs; the subcaudal enlargement with transverse rows of very small hairs, there being from 35 to 40 such rows.



The head-capsule has the usual Hexatomine shape as described for the genus *Eriocera* by Alexander and Lloyd; labrum oval with a strong, rather chitinized frame; on the cephalic margin produced into a small median lobe bearing two small tubercles (Plate I, Fig. 5); the lateral margins are produced into prominent lobes which are directed inward and cephalad, entirely protecting the front of the labrum and almost meeting one another on the middle line; these lobes densely hairy. Antennæ cylindrical, bearing two or three small hairs and one much longer hair (Plate I, Fig. 3). Mandibles long, slender, acutely pointed as in the members of this tribe, with a very large tooth on the inside near the middle of its length, this latter with a smaller tooth at its base, the inner margin basad of these two teeth is roughened with two or three tiny denticles (Plate I, Fig. 1).

Stigmal field with four lobes of which one pair are lateral and directed caudad and slightly laterad, the round stigmata at the base; the outer face of these lobes is provided with numerous long hairs, these being longest at the tip, shorter at the base. The ventral lobes are longer, directed caudad, the tip provided with a few long hairs and some shorter ones which are continued up the ventral face. The dark markings on the stigmal disk are few, a broad brown suffusion extending from the stigmata dorsad; a narrow brown line along the inner face of the lateral lobes, this mark narrowest at the tip, scarcely enlarged at the opposite end; the ventral lobe has a long slender brown mark extending from the tip cephalad, at the proximal end expanded (Plate I, Fig. 7).

Described from numerous larvæ taken at Ithaca, N. Y., May 6, 1914.

#### PUPA

The pupa is quite similar to that of *Eriocera longicornis* differing only in its small size, greater development of the scapal spine, lack of the projection on the mesonotal praescutum, etc. The cephalic crest when viewed from beneath is very different in shape; the fore pair of legs are much shorter than the others, ending just beyond the caudal margin of the second abdominal segment; the hind pair extend far beyond the others, ending beyond the middle

of the third abdominal segment; in some specimens the tarsal segments are much nearer to the posterior margin of the third abdominal segment, but there is always a marked difference in the tips of the tarsi of the various legs.

Male. Cephalic crest viewed from the side, triangular, ending in an acute point which is directed strongly forward (Plate II, Fig. 1). Viewed from beneath (Plate II, Fig. 2), the lobes are conspicuously triangular, pointed, lying parallel or slightly divergent and separated by a deep median split. Spine on the scape of the antennæ very large, conspicuous; tubercle on the labrum strongly developed. Pronotal breathing-horns short, straight. Mesonotum strongly crenulated along the middle line; scutellar lobe not developed. Posterior leg sheaths extending beyond the level of the middle legs, which, in turn, are longer than those of the fore legs. Wing pads dark, the venation not showing clearly, but if made out the very short cell  $R^2$  and the reduced  $M$  are characteristic of *Hexatoma* alone. Abdomen with about 34 spicules on sternite 4; about 30 in a straight uninterrupted row on tergites 3 and 4; about 20 on tergite 5. Hypopygium with the sternal lobes strongly rounded, enlarged and bent strongly dorsad.

Length: From crest to tip of the abdomen, 9.2-9.6 mm.

Dextro-sinistral width at wing-pad: 1.2 mm.

Dorso-ventral depth at wing-pad: 1.4 mm.

Female. As in the male, the ovipositor viewed from the side with an obtuse notch. From beneath, the sternite is obtusely pointed with a deep median split. From above, the tergite is almost flat across the caudal margin, the lateral angles rounded, a deep median split. The antennal sheaths are much shorter than in the male (Plate II, Fig. 3).

Both sexes of the pupæ described from numerous specimens from Cascadilla Creek, Ithaca, N. Y., May 2, 1913; May 6, 1914.

The larva of *Hexatoma* in many respects is close to *Eriocera fultonensis* Alexander in the shape of the markings on the stigmal disk, the teeth on the mandible and the lateral lobes of the labrum. The pupa, on the contrary, suggests *Eriocera longicornis* Walker very closely in the shape of the cephalic crest, appearance of the

caudal end, etc. These differences are pointed out in the following key:

#### LARVÆ

1. Size smaller (fully grown, length, 14-15 mm.); mandible with the largest of the two teeth at mid-length, slender, rather sharply pointed; labrum with the lateral lobes produced cephalad and proximad, almost touching one another on the middle line; stigmal field with the dark markings pale, brown, those of the ventral lobes not enclosing an oval pale area at their proximal ends. *Hexatoma megacera* O. S.
- Size larger (fully grown, length, 18-26 mm.); mandible with the largest of the two teeth at mid-length stout, blunt; labrum with the lateral lobes produced cephalad and scarcely proximad, widely separated from one another; stigmal field with the dark markings black or very dark brown, those of the ventral lobes contiguous at their inner ends and there enclosing an oval pale area. *Eriocera fultonensis* Alex.

#### PUPÆ

1. Size small (length under 10 mm.); scapal spine larger; no projection on the mesonotal praescutum. *Hexatoma megacera* O. S.
- Size larger (length over 12 mm.); scapal spine small; a small projection on the mesonotal praescutum. *Eriocera longicornis* Walk.

#### ERIOCERA Macquart

The information that was available concerning the species of this genus was included in a paper by Alexander and Lloyd cited before (*Journal of Entomology and Zoology*, VI, March, 1914), but since that article was written a few more items concerning the biology of members of this genus have been ascertained.

ERIOCERA BRACHYCERA Osten Sacken.

*Eriocera brachycera* Osten Sacken; Bull. U. S. Geol. Surv., III, 205, 1877.

This species is one of the rarer forms in the Eastern United States. A pair that was collected by the author on August 4, 1914,



as given below, were observed flying rapidly over the creek-bed of a mountain stream in the dense shade of the forest. The known distribution of the insect so far as known is as follows: *New Hampshire*, White Mts., Osten Sacken's type; Bretton Woods, June 27, 1913 (Johnson). *Massachusetts*, Hampden Co., Chester, Aug. 7, 1912 (Johnson). *New York*, Erie Co., South Wales, July 9, 1911 (Van Duzee); Herkimer Co., Old Forge, July 12 to 16, 1905 (Needham); Fulton Co., Pinnacle Mt., alt. 2000 feet, Aug. 4, 1914 (Alexander). *New Jersey*, Warren Co., Delaware Water Gap, July 4, 1898 (Johnson).

ERIOCERA SPINOSA Osten Sacken.

*Arrhenica spinosa* Osten Sacken; Proc. Acad. Nat. Sci. Phila., 244, 1859.

Messrs. Rich and Ellis, while collecting *Corydalis* larvæ in Fall Creek, Ithaca, N. Y., on Oct. 31, 1914, report the finding in immense numbers of large, almost fully-grown larvæ of this species. They formed a high percentage of all the insect life noted in the rapid water. The observations made earlier by Alexander and Lloyd concerning the carnivorous habits of these larvæ were confirmed by Mr. Rich who placed the larvæ in dishes together with nymphs of various Odonata, the smaller ones of which were eaten by the *Eriocera* larvæ.

ERIOCERA LONGICORNIS Walker.

*Anisomera longicornis* Walker; List Dipt. Brit. Mus.; 1, 82, 1848.

This well-known species was discussed in some detail in the paper on *Eriocera* cited before. Many specimens of larvæ and pupæ have been taken and it seems probable that the larva described in that paper is not typical of *longicornis*. It is preferred to await more data before saying anything further about the insect. The distribution as indicated by my sheets is quite extensive being as follows: *Canada*, Ontario, Nagagami R., June 20-21, 1903 (W. L. Wilson); Little Current R., July 8, 1903 (Wilson). *Maine*, reported by Johnson. *Massachusetts*, collected by Packard. *New Hampshire*, Bretton Woods, June 24-25, 1913 (Johnson). *Connecticut*, New Haven

Co., Oxford, May 21, 1904 (Britton). *New York*, Herkimer Co., Trenton Falls, collected by Osten Sacken; Dolgeville, May 16, 1914 (Alexander); Fulton Co., Northampton, May 28, 1914 (Alexander); Tompkins Co., Ithaca, May 1-10, 1913, (Alexander and Lloyd). *Pennsylvania*, Wyoming Co., North Mt., June 7, 1898 (Johnson). *Maryland*, Plummer's Is., April 12, 1908 (Barber); April 21, 1907 (McAtee); Jackson's Is., May 22, 1913 (Shannon and Barber); Cabin John Bridge, May 16, 1909 (Knab). *Virginia*, Fairfax Co., May (Banks). *Illinois*, collected by Kennicott.

The following supplementary notes on the swarming and mating were made at Northampton (Fish-house) on the Sacandaga River, Fulton Co., N. Y., at the boom of the International Paper Mills.

May 27, 1914—This afternoon across the river from our camp this species was exceedingly abundant. They were there in untold myriads and at every step arose in clouds from under foot or from the leaves of choke-cherry on which they rested. They sat on the leaves with the head directed away from the observer ready to take instant flight. A few were in copulation on the leaves, but from observations made it seems probable that mating begins in the air and the pair seek a support later. Toward twilight this insect may be found in great numbers in company with many kinds of caddiceflies and a few may-flies. Seven p. m.—*Eriocera* swarming in great numbers, from 50 to 200 in a swarm facing the gentle westerly breeze (downstream). One big swarm near the shore numbered at least 2000 individuals and covered a vertical height of at least 50 feet, the base of the swarm being about 15 feet above the surface of the water. Coming back across the boom it was found that several of these great swarms had fused so that one almost continuous swarm of thousands of individuals was formed, extending from shore to shore of the river. A great number of specimens were secured by a few sweeps of the net. When danger approaches, the swarm either mounts into the air overhead or else retreats before the breeze, never going sideways or advancing. Out over the land in the small swarms, copulation was observed several times. The males in the swarm dart rapidly at the females and seize them al-

most instantly. Then they usually leave the swarm and go sailing away, the male above doing the flying, the smaller female hanging limply underneath. After a rather short time they break away and the separated individuals depart. When copulation is prolonged, the male becomes tired and the pair rest on the upper surface of the leaves as described *ante*.

May 28, 1914, 7:15 p. m.—Today at this hour, *Eriocera* is swarming in immense numbers out over the river. Copulation was observed many times. The male grasps the female in the swarm and they fly away, the male above doing all the active work of flight, the female below, entirely passive. The antennæ of the male are directed straight ahead and slightly divergent; the legs hang downward; the wings vibrate rapidly. The female hangs downward with the legs hanging limply; the wings nearly horizontal and motionless. The dead weight of the female keeps pulling the male down toward the water and often both fall into the river. As a rule copulation ends before the male is exhausted. The male opens his forceps and the female drops straight downward for a foot or so exactly like a parachute released from a balloon. If the pair are near the water at the time of separation the released female drops into the water, the male flying away. The released male darts upward again and back into the swarm. The female slowly flies away, usually upstream, sometimes downstream, presumably to lay her eggs; she does not stop for swarms that she may encounter but if she meets these swarms she will make a wide detour in order to avoid them. Often a second male will seize a female already in copulation and the three will come tumbling down into the water together.

In a very few cases the female is the active partner and succeeds in pulling the male where she wills although much smaller. In other cases the female before being released from the male flutters the wings violently as though impatient. Copulation occurred commonly this evening and it is probable that the hours of twilight are the usual ones though several were found mating on leaf-surfaces during the afternoon as mentioned earlier. It may be that these matings started in the air and upon the approach of exhaustion the

male retired to a support although the species was never observed to swarm during the hours of sunlight.

The number of individuals participating in these swarms was again very astonishing, many of the swarms numbering thousands of individuals. The motions in the swarms were very rapid, almost like bees, and the sound produced was a very low pitch, much lower than that of *Culex*.

May 29, 1914—A rather strong southerly breeze blowing. At 6:35 p. m. small swarms of from 25 to 30 individuals had gathered. At this time the sun was still up but low in the west. These swarms were enlarged rapidly. At 6:45 one big swarm was formed near the east bank, this being nearest the point where the insects spend their days and so they swarmed there first. One pairing of three individuals came down as described above and when about a foot above a board in the water, the male in copulation dropped the other two. These rested for a moment and then the male attempted to engage the female in copulation. She resisted but finally he managed to seize her with his forceps. Then he attempted to fly away but she seized hold of the board with all her feet and he was unable to fly away. This seems to prove that the normal place for copulation is in the air.

Enemies: Dragon-flies, *Helocordulia uhleri* Selys, feed upon the *Eriocera* swarms during sunlight. They do their capturing by darting back and forth through the masses of individuals.

Oviposition: Many *Eriocerae* were noted engaged in dipping down to the water as though engaged in the laying of eggs. Only a few individuals allowed themselves to be taken and all of those secured proved to be males. Why males should go through these actions is uncertain to me, but I have observed it many times in several different species. I think that the female lays her eggs in the water although no specimens were taken while egg-laying.

#### PENTHOPTERA Schiner

This interesting genus includes but six described species of which *P. chirothecata* Scop., *P. cimicoides* Scop., *P. schnusei* Kuntze and *P. grisea* Riedel are Palaearctic, *P. albitarsis* O. S. is Nearctic and

*P. conjuncta* Alex. is Neotropical. Our very limited knowledge concerning the life-history of members of this genus is confined to the American form and this information may be given in the following pages.

PENTHOPTERA ALBITARSIS Osten Sacken.

*Penthoptera albitarsis* Osten Sacken; Mon. Dipt. N. Am., IV, 257, 1869.

The adult of this fly is well-known and has a wide distribution in the northeastern United States. This distribution so far as known to me, is as follows:

Vermont, Windham Co., Battleboro, July 15, 1908 (Johnson). Massachusetts, Middlesex Co., Weston, July 23, 1911 (Johnson); Plymouth Co., Plymouth, July 28, 1908 (Johnson). Connecticut, New London Co., New London, Osten Sacken's type. New York, Fulton Co., Sacandaga Park, alt. 800 feet, June 28, 1911 (Alexander); Woodworth's Lake, alt. 1650 feet, July 19, 1914 (Alexander); Tompkins Co., "The Glen," August 12, 1910 (Alexander); Sept. 17, 1907 (Needham); Coy Glen, July 11, 1911 (Alexander); Bool's Brook, July 13, 1912 (Alexander). New Jersey, Essex Co., Hemlock Falls, June (Weidt); Warren Co., Delaware Water Gap, July 11 (Johnson); Camden Co., Clementon, Aug. 7, 1892 (Johnson). Pennsylvania, (Cresson) Osten Sacken's type. Virginia, Southampton Co., Boykins, June 10, 1895 (Johnson); Nansemond Co., Suffolk, June 11, 1895 (Johnson); Fairfax Co., Pimmit Run, Sept. 6, 1908 (Knab). North Carolina, Buncombe Co., Black Mts., July 3, 1912 (Beutenmuller). Georgia, Rabun Co., Tallulah Falls, June 21, 1909 (Bradley).

From the above data it is seen that the fly is on the wing from June until September, being most abundant probably in July. The insects occur in cool, shady places and may be swept from the luxuriant vegetation growing in such locations.

The larva differs widely from the related Hexatomine genera in the habitat in which it dwells (in mud instead of sand and gravel); in the bright yellow coloration and in structural details; the mandible with one very broad tooth at its middle, this tooth deeply split; stigmal field surrounded by four rather short lobes, each of the



ventral pair bearing one extremely long hair; sub-caudal arrangement with the transverse rows of hairs large and comparatively few in number.

The pupa may be distinguished by the blunt breathing horns with the enlarged tips, the weak character of the hairs forming the transverse sub-caudal rows on the abdominal sternites.

The larvæ have been found in several widely separated localities and the following general statements seem to apply: It is found in rich organic soil, sometimes rather dry, at other times more saturated; in "The Glen," Ithaca, N. Y., this soil is very dark brown, in Simmons' Woods, Gloversville, N. Y., almost black in color. Their haunts are almost invariably surrounded by tall shade trees. Small streams are always near at hand and the larva may well begin its career in the water. This habitat is quite different from the sandy or gravelly situations in which the larvæ of *Eriocera* and *Hexatoma* occur. The larvæ have all of the Hexatomine characters and the quick, active movements of their relatives. However, the bright yellow coloration of the body is quite distinct from the known larvæ of the other genera. The record of the occurrence of these larvæ is as follows:

March 27, 1914—Rich organic mud was sifted to-day ("The Glen," Ithaca, N. Y.) and one larva was found in association with the larvæ of other crane-flies, *Rhaphidolabis tenuipes* O. S., common; *Rhypholophus nubilus* O. S., a few; *Molophilus hirtipennis* O. S., abundant, and other Tipulid larvæ; also a few of *Dixa modesta* Johann. (= *clavulus* Will. (?) ). This larva was placed in a vial and was seen alive at various dates until June when it was no longer to be found. The vial was examined on June 30, but no part of the insect could be detected.

April 10, 1914—More of the rich organic mud from "The Glen" was examined and five larvæ found; 2 were placed in vial No. 17, 1 in vial No. 18. These vials were examined on June 30, vial 17 was spoiled; vial 18 contained one healthy larva, rather small.

April 17, 1914—More mud from "The Glen," one larva being found. Natural associates at this time were the larvæ of the following crane-flies: *Rhypholophus nubilus* O. S., *R. nigripilus* O. S.,

*R. meigeni* O. S., *Molophilus hirtipennis* O. S., these larvæ being rather common. Also several of the big white Leptid larva, *Chrysopila thoracica*, and many beetles and worms. Examined on June 30 and found to contain one healthy larva.

June 1, 1914—Rich, wet, organic mud taken from along the railroad embankment at Sacandaga Park, N. Y. This yielded a few crane-fly larvæ of the tribes *Eriopterini*, *Limnophilini* and *Tipulini*, as well as one of *Pentoptera*. It was placed in vial No. 52 and on June 30 emerged as an adult male.

June 9, 1914—In Simmons' Woods, Gloversville, N. Y., rich black mud from along the creek in shaded places was examined and yielded a few *Eriopterine* larvæ and one *Pentoptera*.

The immature stages may be described as follows:

#### LARVA

Length: Fully extended, 10-12 mm.; diameter, 1-1.2 mm.

Color bright chestnut-yellow, the cephalic half richer and deeper colored, the thoracic sclerites suffused with brown; the sub-caudal enlargement, when expanded, whitish; the skin with silky, sub-iridescent reflections.

Head-capsule rather broad, the genal plates with the inner cephalic angles rounded, and the caudal inner angle produced caudad in a long point. The labrum is quite similar to that figured for *Eriocera spinosa* (Journ. Ent. and Zool., VI, Pl. I, Fig. A, 1914). Mandibles of the usual Hexatomine type, long, slender, pointed, in a position of rest pointing caudad; the inner margin provided with teeth, a double tooth at about mid-length of the organ and a prominent knob midway between these teeth and the base of the mandible. (See Plate I, Figs. 2, 4, and 6.)

The caudal end of the body with four lobes, two being lateral and two ventral in position (Plate I, Figs. 8 and 9). The lateral lobes are provided with a dense fringe of rather short yellow hairs, these hairs directed laterad. The ventral lobes are densely clothed with long pale hairs which are directed ventrad and a few scattered longer filaments; one very long bristle from each ventral lobe, this being much longer than the segment which bears it. The stigmal disk is almost free from darker markings, a faint brown line extend-

ing from the stigma dorsad and a less distinct brown line along the ventral margin of the lateral lobe. Gills four in number, pale. The sub-caudal enlargement is provided with transverse rows of fine hairs or delicate spicules, there being about twenty-five of these rows which evidently serve as an aid to propulsion. These rows of hairs are much coarser than in related forms (*Hexatoma*, about 35 rows). The spiracles are circular, situated at the base of the lateral lobes. The body is provided with numerous long, appressed hairs. A few long hairs or short bristles on the body of which the following may be mentioned: One on the latero-dorsal margin of the last segment near the base of the lateral lobes; a series of four groups of one or two in each across the dorsal surface of the first three thoracic segments at about mid-length; a group of two or three long hairs on the sides near the caudal margin of the dorsal segments.

Described from numerous larvæ from Ithaca and Gloversville, N. Y.

#### PUPA

Cephalic crest small, depressed, rather inconspicuous, each half consisting of three setiferous lobes. The breathing horns (Plate II, Fig. 4) are short and stout, red at the base and apex, the portion in between darkened and wrinkled transversely; the enlarged apex is very brittle and easily broken off. The mouth parts are about as in *Eriocera* (Plate II, Fig. 6) as figured before (l. c., Plate II, Fig. A), but the lobes of the labium are broader and more evenly pentagonal. The wing-pads extend to just beyond the tip of segment two of the abdomen; leg-sheaths extending nearly to the base of the fifth abdominal segment; the legs end about on a common level, the outer pair very slightly the longer, the inner pair a little the shorter of the three.

Sternites with the basal half feebly wrinkled transversely, the caudal half more chitinized and bearing a few weak hairs or slender spicules arranged as follows: Segment 7, two small bristles near the base and closer to the middle line; four small hairs near the caudal margin, widely separated. Segments 4 to 6 (Plate II, Fig. 7) with a sub-caudal row of rather weak slender hairs, this row

consisting of from 45 to 50 such hairs; nearer the base and closer to the median line are small hair-bearing areas with one large and one small hair, the larger being the more proximad, the other lying outside it. Segment 4 is hidden by the leg-pads but the hairs are present.

Tergites with four small tubercles on the dorsal side of the 8th segment, the more caudal pair being the larger, the cephalic pair a little smaller. Segments 1 to 7 (Plate II, Fig. 8), with six groups of hairs arranged as follows: A cephalic group near the lateral margin of the chitinized portion of the segment, consisting of two hairs; directly caudad of this group near the caudal margin of the segment, a second group of two hairs; proximad and very slightly cephalad of this latter group is a third group consisting of a large inner hair and a smaller outer one.

Segments 2 to 7 have the fleshy wrinkled pleural region rather extensive, one small hair immediately caudad of the spiracle. Eighth segment with a few scattered hairs near the caudal margin, these hairs being ventral, two pairs; lateral, one pair; subdorsal, about three pairs. Ninth segment with the tergal lobes rather conspicuous, directed sharply dorsad, the extreme tip a chitinized tooth (Plate II, Fig. 5).

Length: From crest to the tip of the abdomen, 9.2 mm.

Dextro-sinistral width at the wing-pads: About 1.6 mm.

Length of the breathing-horn: 1 mm.

Description taken from a cast skin.

## EXPLANATION OF THE PLATES

## I. LARVÆ

- Figure 1. Mandible of *Hexatoma*.
- Figure 2. Mandible of *Penthoptera*.
- Figure 3. Antenna of *Hexatoma*.
- Figure 4. Antenna of *Penthoptera*.
- Figure 5. Labrum of *Hexatoma*, dorsal aspect.
- Figure 6. Labrum of *Penthoptera*, dorsal aspect.
- Figure 7. Dorso-caudal aspect of the end of the abdomen of *Hexatoma*.
- Figure 8. Dorso-caudal aspect of the end of the abdomen of *Penthoptera*.
- Figure 9. Lateral aspect of the end of the abdomen of *Penthoptera*.

## II. PUPÆ

- Figure 1. Lateral aspect of *Hexatoma*; male pupa.
- Figure 2. Ventral aspect of *Hexatoma*; male pupa.
- Figure 3. Ventral aspect of *Hexatoma*; female pupa.
- Figure 4. Breathing horn of *Penthoptera*; male, dorsal aspect.
- Figure 5. End of the abdomen of *Penthoptera*; male, lateral aspect.
- Figure 6. Pupal mouth parts of *Penthoptera*; ventral aspect.  
a. Labrum; b. maxilla; c. labium.
- Figure 7. Sixth sternite of the abdomen of *Penthoptera*, showing the arrangement of the setæ; ventral aspect.
- Figure 8. Fourth tergite of the abdomen of *Penthoptera*, showing the arrangement of the setæ; dorsal aspect.